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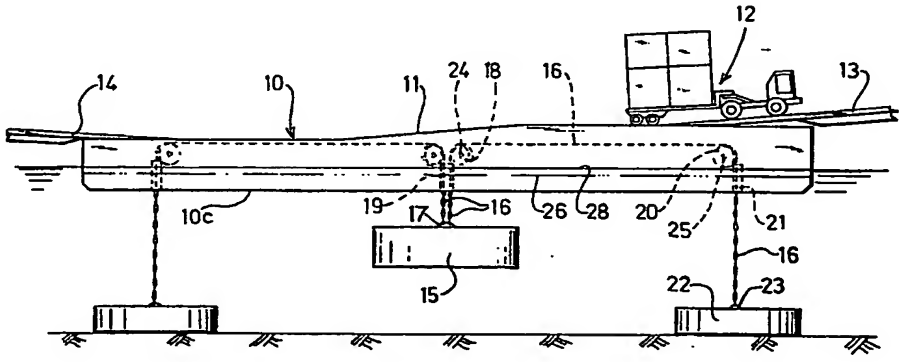
(71) Applicant
Navire Cargo Gear
International AB
Gustaf Dahlensgatan 8
Goteborg
Sweden
(72) Inventor
Allan Sernhag
(74) Agents
Marks & Clerk

(54) **Stabilizing floating structures**

(57) To maintain the deck of a floating structure eg a landing pontoon 10 level, a weight (15) is suspended below it by lines (16) and the lines extend from a common point of attachment (17) on the balancing weight over rotatable leads (18, 20) on the floating structure to bottom anchors (22). When the floating structure is subjected to a heeling moment from a passing load (12), the distribution of the strains in the lines changes whereby the floating structure moves in parallel downwards to a new water level.

FIG.1



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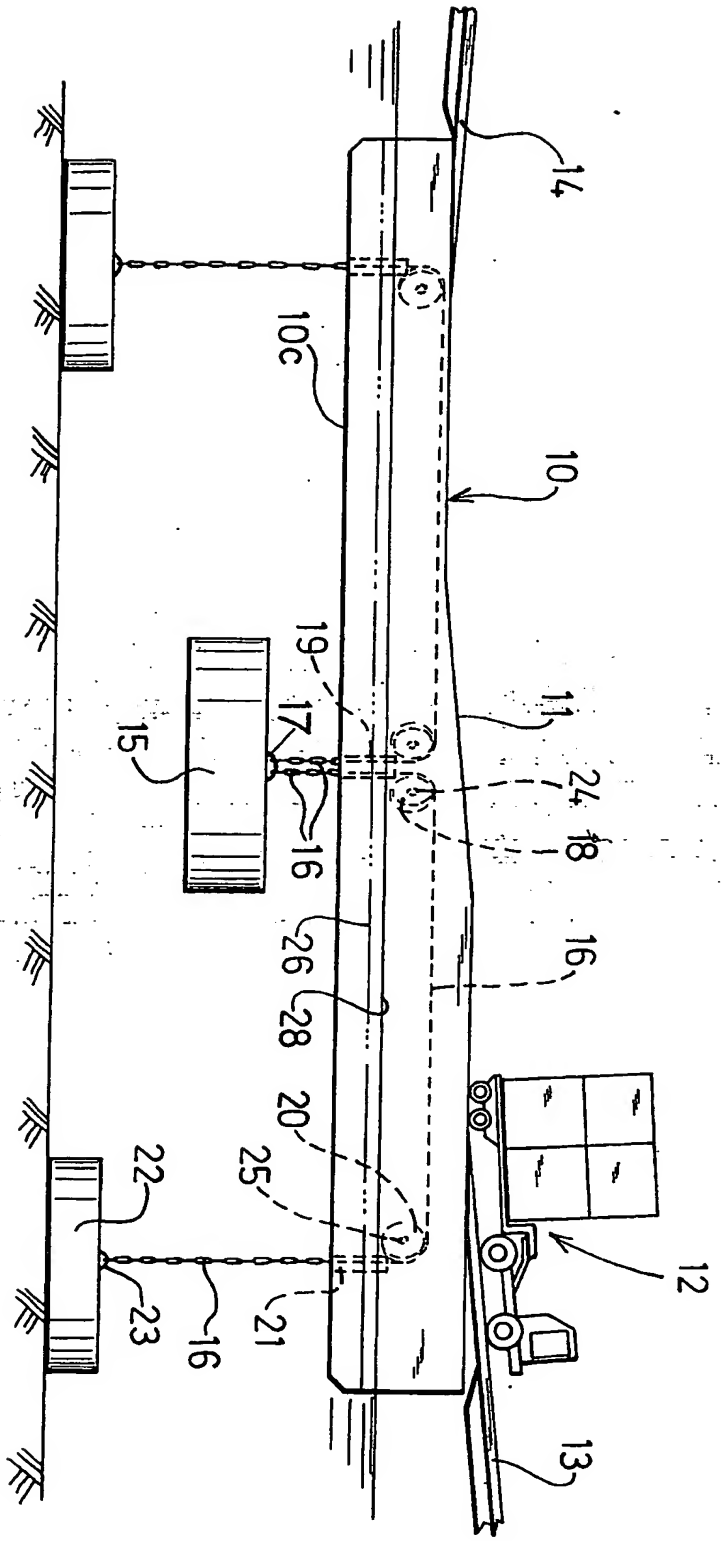

FIG.1

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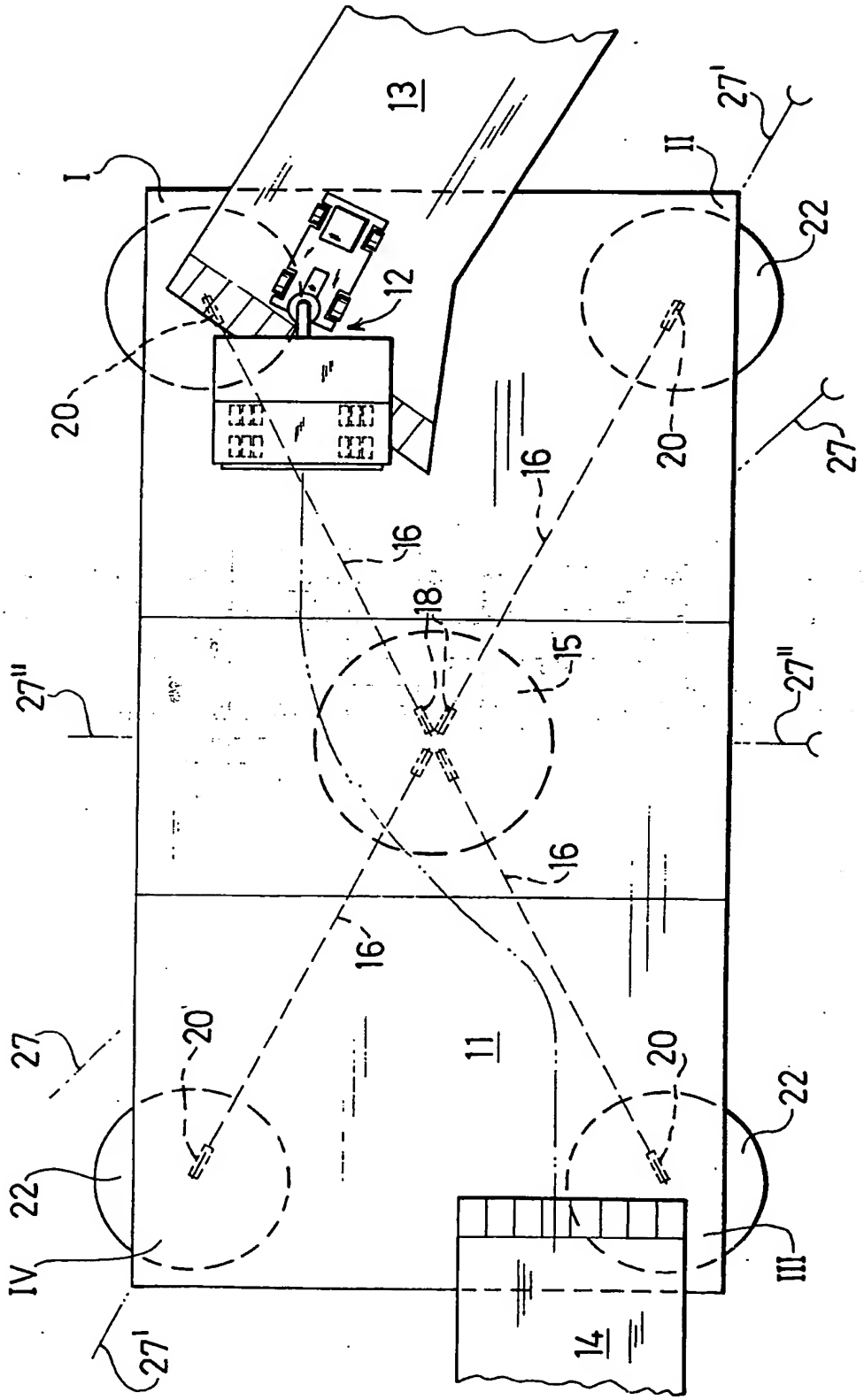
FIG. 2



SPECIFICATION

A stabilizing device for floating structures

This invention relates to a stabilizing device for floating structures.

When loading and unloading Ro-Ro ships (horizontal cargo handling) use is often made of a floating structure (a pontoon) forming part of a roadway between a ramp of the ship and the quay. With such an arrangement, a so called "floating linkspan", a continuous cargo handling is possible in ports where there is a noticeable difference in tide water levels, independently of the size of the ship and the design of its ramp. Continuous handling is impossible if the ship is moored directly at the quay where tide water level varies, and the said arrangement provides inexpensive, easily installed and more flexible alternative, than a permanent quay.

Modern systems for horizontal cargo handing mean that heavy pieces of cargo will have to be moved across the floating structure, and will load the latter unsymmetrically with respect to the centre of gravity of its displacement. This brings about heeling movements, which have to be counteracted so they do not impart unfavourable strains upon the ramp or impair the handling.

In order to reduce the heeling angles, the displacement volume of the floating structure may be extended lengthwise and transversely in relation to the actual need for roadway area. Other solutions, including automatic arrangements for changing the angular position of the ramp, as well as adjustable bottom anchor devices have been proposed. Such solutions are, however, expensive and the former one will furthermore require a lot of extra space.

The object of the present invention is to simplify the design and to reduce the costs of, *inter alia*, linkspan installations, and proposes a device for counteracting heeling tendencies at floating structures, which removes the disadvantages above referred to.

The invention is characterised by a balancing weight suspended below the floating structure, a number of mooring means disposed, in use, at the sea bottom, a number of weight distribution line members each running from a mooring means by way of the floating structure to a common point of attachment at the balancing weight, and a number of inward and outward leads rotatably mounted about horizontal axles in the floating structure and arranged, in pairs, to support the line members at their extensions directed towards the balancing weight and the associated mooring means, respectively.

Such a device used with a floating structure having a basically parallelepipedic body, is preferably characterised in that the inward leads are located so that the gravity force of the balancing weight, in an equilibrium position, will act along the vertical centre axis of the floating structure and that the outward leads are located at equal distances from said axis.

Depending upon the expected load acting unsymmetrically, or symmetrically, with respect to a centre line through the floating body, the device may include four outward leads, each located in a corner portion of the floating structure, at vertical planes arranged diagonally through the body or two outward leads, located at the end of the center line plane through the body.

A floating device according to the invention may easily be shifted from one position to another, if the mooring means are secured by means of bottom anchors.

The invention will now be described by way of example, with reference to the accompanying drawings, in which:–

Figure 1 is an elevation of a stabilizing device according to the invention, as used with a link-span pontoon, and

Figure 2 shows a plan view of the arrangement of Fig. 1.

In Figs. 1 and 2 reference 10 denotes a floating structure having a basically parallelepipedic body, an upper face 11 of which forms a road-way for cargo transferring vehicles 12, as well as supports for a land based ramp 13 and a ship based ramp 14.

In order to offset heeling tendencies when a vehicle 12 loads the roadway 11 unsymmetrically, a balancing weight 15 is suspended below the floating structure 10, hanging from four line members 16. These run together upwards from a common point of attachment 17 at the balancing weight to inward leads 18 by way of a central passage 19, extending centrally upwardly from a lower face 10*c* of the floating structure. The lead 18 will guide each line member diagonally outwards to an outward lead 20, located at a corner portion of the floating structure. Further passages 21, running about vertically downwards will pass on the line members, each to a pertaining mooring means 23, here formed at bottom anchors 22.

The leads 18 and 20 are mounted so as to be easily rotatable about horizontal axles 24 and 25, respectively, fitted so the line members will pass freely through passages 19 and 21. The outward leads 20 are furthermore located at equal distances from the central passage 19, and at the same level above the bottom face 10*c* of the floating structure as the inward leads 18. The passages 19, 21 are preferably formed as vertical tubes extending upwards from the bottom face and having a height well exceeds the maximum immersion of the floating structure.

The line members preferably include chains or similar flexible wire means, and are thus easily shuffled in relation to the floating struc-

ture, so they will always be stretched by the balancing weight 15, independently of variations in water level and of passing loads. The lengths of the line members are selected so the balancing weight will hang freely also when the floating structure is unloaded at highest tide water level.

The floating structure may easily be prepared for towing in ports where the tide water level varies, by locking the line members 16 at low tide water level. The displacement of the floating structure will then raise the bottom anchors 22 during flood tide, so towing to another position may be arranged. Lifting of the bottom anchors may of course also be carried out by means of a winch, or some other suitable device.

The profile of the sea bottom, and the depth can vary at different locations of the port, and the line members ought to be designed to permit an adjustment of their lengths. Suitable means, for instance permitting the insertion, or the removal, respectively, of extra chain lengths, may be included in each line member 16. Together with the fine adjustment means, such as turn-buckels or the like, the lengths of the line members can easily be individually adjusted, as called for by the local bottom conditions, so the action of the balancing weight will be uniformly distributed upon the four line members.

With properly adjusted line members 16 the unloaded floating structure will attain a floating position defined by a water line 26 (Fig. 1) being parallel to the bottom face 10c. In this position reaction forces from the line members acting upon lead axles 25 will be alike. When the roadway is loaded by a vehicle 12, for instance at one corner of the floating structure, as shown in Fig. 2, the strains in adjacent line members will be reduced due to the heeling movement of the floating structure with respect to a horizontal heeling axis 27, passing through the centre of gravity of the displacement body (the floating centre). The reduced strain in one line member will, due to the freely suspended balancing weight, cause a corresponding increase in an opposite line member. The resulting heeling moment will thus be zero, and a vertical displacement of the floating structure, as a result of load 2, will follow to a new water line 28 (Fig. 1).

The dimensioning of the balancing weight 15 will have to be selected with respect to the mgnitude and possible location (driving direction) of the expected load. A minimum of reaction forces will occur when the load acts so the floating structure tends to heel in relation to a diagonal axis 27′, as indicated in Fig. 2. Only the line member extending towards corner I will then be relieved, and a reaction force, as a maximum corresponding to one half of the weight of the balancing weight, will act at corner III. The full weight of the balancing weight will result in reaction moments when the loads acts in any of the symmetry lines of the roadway 11. During a rotation in relation to a heeling axis 27″ (Fig. 2) a full relieving of the line members extending from corners I and II, will double the strains in each of the line members extending from corners III, IV, i.e. the full weight of the balancing weight will lbe uniformly distributed between last mention corners. Reaction forces occurring during an optimal heeling axis 27 (as used above) will lie inbetween the extreme values indicated above.

Different types of ship's ramps may impart different loads, which however will be taken care of by the balancing device.

The removable bottom anchors may be substituted by stationary means such as anchoring irons. If bottom anchors are used (as in the embodiment described) the weight of each of them should exceed one half of the weight of the balancing weight.

A floating structure which, due to the shape of its roadway and the location of the associated ramps, will be loaded along its centre line only, may be provided with two line members only, extending in the plane of the centre line, and being passed over leads arranged at equal distances from the balancing weight.

CLAIMS

1. A device for counteracting heeling movements at a floating structure, characterised in a balancing weight suspended below the floating structure, a number of mooring means disposed, in use, at the sea bottom, a number of weight distribution line members each running from a mooring means by way of the floating structure to a common point of attachment at the balancing weight, and a number of inward and outward leads rotatably mounted about horizontal axles in the floating structure and arranged in pairs, to support the line members at their extensions directed towards the balancing weight and the associated mooring means respectively.

2. A device as claimed in claim 1 used with a floating structure having a basically parallelepipedic body, characterised in that the inward leads are located so the gravity force of the balancing weight, in an equilibrium position, will act along the vertical centre axis of the floating structure and that the outward leads are located at equal distances from said axis.

3. A device as claimed in claim 2, characterised in that it comprises four outward leads, each located in a corner portion of the floating structure at vertical planes arranged diagonally through the body.

4. A device as claimed in claim 2, characterised in that it is provided with two outward leads, located at each end of the centre line

plane of the floating structure.

5. A device as claimed in any one of claims 1 to 4, characterised in the mooring means being secured by means of bottom anchors.

6. A device as claimed in any one of the preceding claims, characterised in each line member having means for adjusting its length.

7. A device for counteracting heeling movements at a floating structure substantially as hereinbefore described with reference to and as shown in Figs. 1 and 2 of the accompanying drawings.

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